60 Hz Power Fields: The Latest Danger

What you don't know can hurt you.

by Paul Danzer N1II

We have been reading and hearing about the dangers of RF radiation for some time now. Leakage from older microwave ovens, cellular phones, handie-talkies—all of these are known producers of RF radiation. The possible effects are scary. For example: If you put meat in a microwave oven or any other strong RF field it will cook!

But now many scientists are warning us that the 60 Hz power which we use in our homes and ham shacks may also be hazardous to humans. This problem is different from the RF cooking problem, but it is still something we need to carefully examine!

Any time you have wires with a current flow you will have energy being radiated into the surrounding area. Part of the energy is in the form of an electro*static* field, and it varies with the voltage present. The other part of the energy is in the form of an electro*magnetic* field, and it varies with the amount of current flowing. However, since most hams are not exposed to very high voltages without a metal cabinet or shield around the voltage, it is the electro*magnetic* field which we should first look at.

As you probably remember from your school days, the entire earth has a magnetic field (see Figure 1), which is very handy because it lets us use such nice devices as compasses to navigate. Therefore, we are always surrounded by a magnetic field, but the earth's field is DC. That is, it maintains the same orientation all the time and does not alternate or reverse direction like the fields caused by 60 Hz power conductors.

The real question with the 60 Hz power lines surrounding us is whether there is need to worry about radiation. Are the sort of magnetic fields we are exposed to each day in our shacks and our homes dangerous? Millions of dollars are being spent at this minute to try to answer this question. There are many debates over mountains of evidence, and no real definitive answer yet. But since there is a real question, we should take a look at how strong the fields are which surround us. Then when we read in the newspaper or hear on CNN about the results of some of these studies we will have an idea to what extent they might affect us.

Where Do the Fields Come From?

Whenever current flows, a magnetic field is generated. Years ago it was considered fun to determine the direction of the magnetic field around a wire-carrying current. Old-time hams used to use their thumbs to show the direction of current flow in a wire and their curled fingers to show the direction of the magnetic field. Depending on the definition, either the right hand or the left hand was used to demonstrate the relationship. However, the real importance is shown in Figure 2: When current flows through a wire there is a magnetic field generated around the wire.

If the wire is wound into a coil, the magnetic field is concentrated in the center of the coil and flows around, as sketched in Figure 3. The strength of the magnetic field is generally proportional to the number of turns and the current flowing. Double the number of turns of wire and the field strength doubles; double the current flowing and the field strength again doubles.

When the coils or inductors are part of a transformer, a small part of the magnetic field generated in the transformer flows through the open air so that if you measure the field around a power company pole transformer (Figure 4) you will be able to detect this open-air field.

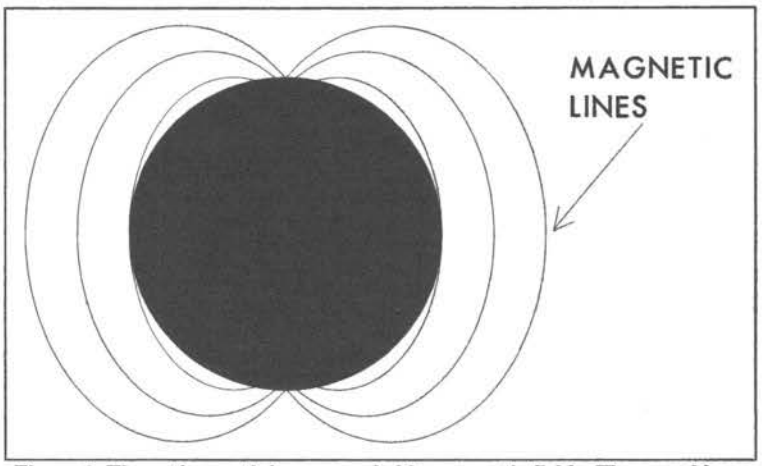

Figure 1. The entire earth is surrounded by magnetic fields. These enable us to use devices like the compass for direction finding.

You can get one clue from looking at Figure 5. Here two wires, connected to a light bulb, are running side by side. The currents in both wires are identical but flow in opposite directions at any instant. Therefore, the magnetic field surrounding each wire is identical but it is running in the opposite direction. If the two wires are close together the two opposite magnetic fields virtually cancel each other—so if you want to minimize the field from 60 Hz wiring, keep both leads together.

Incidentally, the power company and most manufacturers want to keep these magnetic fields around transformers, motors, and other devices as low as possible. In these devices energy is transferred by way of the magnetic fields. These fields flow in the metal cores of the devices, and stray fields in the air do not do very much useful work. They just lower efficiency and waste power.

Most houses and shacks are wired with two conductor cables (ignoring the "green" or ground wire). Therefore, the current flow in one wire is supposed to be the same as the flow in the second wire. Unfortunately, occasionally there is a problem or "ground fault," which allows some current to flow in the ground wire or some other conductor. We will take a look at one possible fix for this later.

Photo A. A magnetic field strength meter like the one used in researching this report.

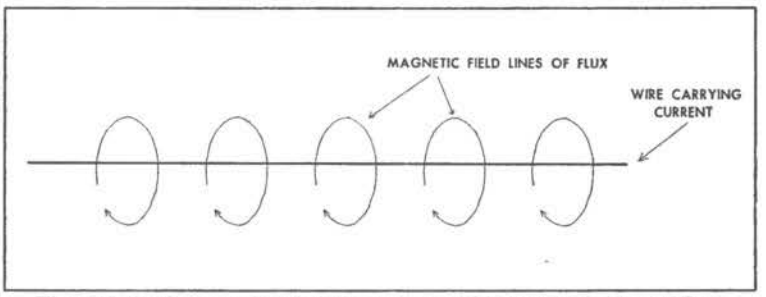

Figure 2. A wire carrying electric current and its magnetic lines of flux.

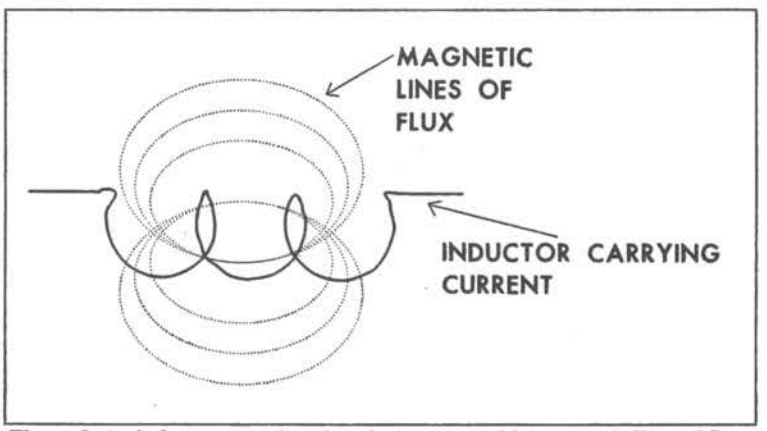

Figure 3. An inductor carrying electric current and its magnetic lines of flux.

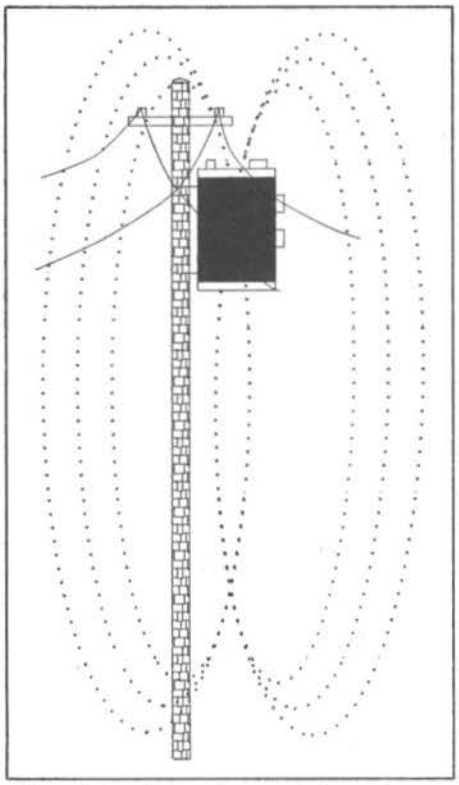

Figure 4. A utility-pole-mounted transformer and its magnetic lines of flux.

How Much is Too Much?

So far, only Sweden regulates magnetic field safety. Their requirement, known as MPR II, is taken very seriously by many equipment manufacturers worldwide. As an example, both American and Japanese suppliers of computer monitors are now advertising that they meet this specification. Even though the danger is not "proven," it is important to people who sit for a long time in front of these electronic devices to know that the magnetic radiation is low. Perhaps we hams, who sit for long periods in front of our rigs, should also take it seriously too.

Without going into the depth and details of the Swedish requirement, it calls for a magnetic field strength of no more than 250 nanoteslas (or nT). This is a measurement unit used in Europe. Here in the United States the usual unit is the gauss, and 1/10,000 of a gauss is one tesla. Therefore, in conventional American units the requirement would be 2.5 milligauss or (mG).

Just to give a little feeling of reality, many discussions of these values state that an average of 0.5 mG is common for most houses. This is an average, and is measured by a process of taking a large number of readings around the house and calculating the average.

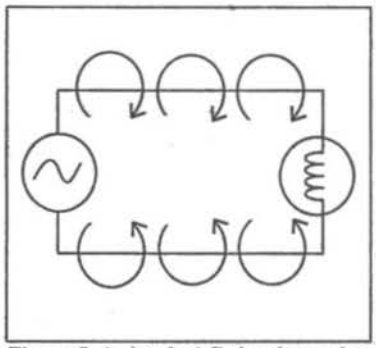

Figure 5. A simple AC circuit consisting of a power source, a lamp, and two conductors. Notice that the magnetic lines of flux in these conductors are in opposite directions.

Measurements Around the Ham Shack

An acquaintance of mine was kind enough to lend me a model 20/25 magnetic field meter (Photo A) made by Magnetic Sciences International in Sausalito, California. He purchased the meter (for less than $300) when he moved into a new office and found himself staring at a set of high-tension wires on steel towers at a distance which seemed to be less than 50 feet. Under this circumstance, he felt the purchase price was well worth the value!

The meter consists of a sensor which can be plugged into an accompanying digital millivolt meter.

Table 1 is a summary of a number of readings I took with the meter. As you can see, most readings were low and very repeatable. Certain fluorescent ballasts and some power supplies were the only sources of high field strength in my survey.

The low values measured outside near the power company's equipment were a pleasant surprise, but remember that they have been concerned about both health and efficiency for many years. Obviously, magnetic fields in the air do not deliver power to the intended source very efficiently.

OK, What Should We Do?

At this point we still don't know if there is a real danger but we do have an idea of what goes on in our shacks. Therefore, if there are a few things we can do to improve our health and safety and they neither cost us very much nor inconvenience us, perhaps we should do them.

First of all, move your power supplies. Whenever you have a separate power supply, move it as far from the operating position as the cables will allow. You don't need it right in front of you, and it can be controlled remotely with a surge protector strip. You *do* use one of these strips for lighting and power line surge protection, don't you?

Next, consider changing to a ground fault interrupt outlet (GFI). Most building codes now require them for bathrooms and outdoor outlets anyway, and if stray ground currents are a source of increased magnetic fields the GFI outlet will trip the current off if the stray current is above a preset level. It is not clear how much you can accomplish this way, but GFI outlets are a good general safety precaution, so it won't hurt.

Keep your primary or AC supply wires paired together. If you use ordinary double conductor line cord this requires nothing extra. When you build a project try to keep the supply wires together as well.

Some of the less expensive power supply equipment I measured had higher field strengths. Table 1 only included a small sample of those measured. One clue, and it is no more than a clue, is that when one of the little "brick"-type power supplies ran hot it also seemed to have a high magnetic field strength. This might have been due to poor efficiency.

Examine the new equipment advertisements carefully. Computer monitor manufacturers have found it was good business to meet the new Swedish requirement, and perhaps ham and other electronic manufacturers will find it is also good business for them.

Finally, keep on reading. Things change as we learn more and more. There is a great deal of money being spent on this problem both by private industry and by governments. Stay up-to-date. How many of you remember when "doctors" in white coats used to extol the benefits of smoking one or another brand of cigarettes, on television?

A Word of Thanks

To Paula Taupier, a Northeast Utilities transmission engineer in Hartford, Connecticut, who was kind enough to supply both literature and contact with other Northeast engineers for information on their lines and transformers. Also thanks and credit to Magnetic Sciences International who supplied the photograph of their meter. Finally, thanks to the local gang who allowed me to invade their shacks to take measurements. RF

Table 1. Measurements

Measurements were taken in and around the shacks of a number of local hams. The values given are in mG, which is the abbreviation for milligauss. Where no distance is specified the reading was taken 6" from the front panel of the equipment. Readings of 0.5 or less are usually due to household or shack background, and not the equipment alone.

Two-bulb 40 watt fluorescent workbench fixture measured at the workbench 36" from fixture.	OFF — 4 ON — 4
100 watt incandescent lamp measured 6" from the lamp.	OFF — 0.1 ON — 2.3
22 watt circular fluorescent lamp surrounding a magnifying lens Measured 3 inches from the center of the lens.	OFF — 0.2 ON — 1.0
Ballast for the lamp above, mounted in the weighted base of lamp fixture. Measured 6" from the ballast	OFF — 2.0 ON — 90 (No, this is not a typo.)
Yaesu FT-901DM HF transceiver, new in the early 1980s.	OFF — 0.6 ON — 8.0
Radio Shack PRO 2005 scanner.	OFF — 9.2 ON — 9.2
Heathkit dual-channel 25 MHz oscilloscope IO4225.	OFF — 1.9 ON — 1.9
Radio Shack "Boom Box."	OFF — 3.5 ON — 3.5
Isolated telephone wires, telephone not in use.	3.5
Discount brand power strip with surge suppressor. This was by far the worst of several tested.	OFF — 0.5. ON — 180
KEPKO power supply—a relic of the 1950s.	OFF — 2.5 ON — 120
6" from a PC clone keyboard and NEC 15" monitor (computer 36" away).	OFF — 0.1 ON — 3
Tower case PC clone (metal case).	OFF — 0.1 ON — 0.3
Hammarlund SP 600 receiver.	OFF — 0.1 ON — 1.9
ELMAC AF 67 (rather old transmitter). Power supply is remote.	OFF — 0.5 ON — 0.5
Drake T4 Transmitter (remote power supply) stacked with Drake R4 receiver.	OFF — 0.8 ON — 5.0
PK 232 controller running packet.	ON (only) 2.0
IC28H stacked with ASTRON RS 12A power supply.	OFF — 0.5 ON — 30
12 volt 1 amp Radio Shack power supply RS 273-1653A.	OFF — 0.7 ON — 70
Yaesu FT757GXII HF transceiver next to a FP757HD power supply. Measurement taken 6" from the transceiver's front panel.	OFF — 2.2 ON — 2.5
Yaesu FL2100B linear amplifier with internal power supply.	OFF —2.7 ON — 46 (non-radiating)
37.5 kVA power company transformer fed by 4.8 kV line, sending 220 volts single phase to several homes. Transformer is at least 15 years old Reading taken at head level below transformer on a 25-foot wooden pole.	0.2 - 0.5, varying with time of day (assume it varies with power consumption in the homes).
15 kVA transformer. Same condition as above. Transformer probably over 30 years old.	0.1 to 0.2
Random points below 4.8 kV feeder lines on 25-foot wooden poles.	0.1 to 0.2 (No real indication there were power lines in the vicinity.)
27 kV area feeder lines on 50-foot poles.	16 to 70 measured. Variation with load. Usually when it measured at the high end. Within 15 to 30 seconds the reading went back down to 16 to 20. Probably due to changed loading or load balance on the lines.